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Systems and Infrastructures to Implement Sustainable Space Development and Settlement - Systems (2A)

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IN-SPACE ASSEMBLY: HUMAN SYSTEM INTEGRATION CONSIDERATIONS

Abstract

In-space robotic manufacturing and assembly is a cornerstone to realizing new depths of space exploration; and to prepare for, and support human presence as we venture forth. Autonomous in-space assembly (iSA) has recently been identified as a topic of interest to advance the mutual objectives of the National Aeronautics and Space Administration (NASA) and several other United States governmental agencies with space interests. NASA's In-space Robotic Manufacturing and Assembly (IRMA) effort seeks to mature ground-breaking technologies for infusion into government and commercial programs "to dramatically extend human capabilities and opportunities in space and to enable more frequent science and discovery missions in Earth orbit, across the solar system and beyond. Technologies within the scope of this work include: novel materials and assembly processes; hardware capable of building and assembling large, complex structures and components in space; additive manufacturing (3-D printing); adroit and reconfigurable robotics; advanced control software to enable robotic situation awareness, intentionality specification and communication; and reactive planning. Autonomous/robotic iSA promises to reduce the costs and potential human hazards associated with hardware transfer and assembly activities. However, even a seemingly autonomous operation must consider potential touchpoints with humans in its concept of operations—from deployment to retirement—and in the design, use, and maintenance of the resulting systems. Failure to do so at onset has resulted in safety and cost risks in past technology enterprises.

This paper provides a Human System Integration (HSI) framework for considering impacts to and from humans for highly autonomous robotic in-space assembly. HSI addresses such considerations throughout the lifecycle of a technology development effort, and pertains to all personnel involved with a given system; including users, operators, maintainers, assemblers, ground support personnel, logistics suppliers, and personnel trainers. HSI domains collectively define (a) how human capabilities and limitations impact the design, effectiveness, operation, support, and associated cost and affordability of a system; and (b) how the system hardware, software, and environment impact and support human performance with it (NASA/SP–2015-3709).